STANDARDS FOR COLLECTIONS AND HOW TO ACHIEVE THEM

CHICORA RESEARCH CONTRIBUTION 207

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Let's hit the ground running — this is a tough topic. A lot of institutions, frankly, just aren't interested because they would prefer to collect than preserve. Others aren't interested because they have a sense of hopelessness — nothing will be done, so why bother. Most collection managers are from humanities backgrounds and the very mention of something approaching hard science sends shivers up and down their collective spines. And others are just plain unconscious — they don't have any idea that they have a problem — and aren't at all interested in finding out.

The fact that you folks are here put you in another category — at least you're interested and willing to try. It's my responsibility over the next hour or so to make sure your heads don't fall back, your eyes roll in, and loud snores begin. I promise to do my best.

When we speak of standards, we usually mean standards to preserve organic based materials from deterioration. We leave aside, if you will, the threats from natural disasters, theft, and mishandling. Deterioration, however, is a rather generic term. And it can take many forms — there is pollutant-induced deterioration, light-induced deterioration, biological deterioration, and physical deterioration. Today I will limit my comments to pollutant-induced and physical problems, leaving light and pests for another day. Pollutant-induced deterioration has a strong RH dependency and involves chemical reactions. Physical deterioration involves changes, especially rapid changes, in temperature and relative humidity. But please remember that by using this distinction I am creating an entirely arbitrary construct. In reality it is impossible to so easily separate all of the things that affect collections.

It's also only fair to warn you that this topic will require a very dedicated audience. We'll go through a lot of material very quickly. Some of it will be technical. Much of it will have to be generalized, so you must adapt it to your specific situation. In addition, there will be no "silver bullet." There is no simple answer. For those institutions who want a perfect climate, but don't want to put any money in it, I have no advice. The bottom line is that preservation costs money — even the least expensive options still have a cost, in either hard cash or staff time.

Why Worry?

Perhaps a good place to start is to understand why environmental controls are important. For the moment, let's not worry with what they should be, let's just concentrate on why we should be concerned.

I'm also not going through the ethical responsibility we have as managers of collections. Nor will I talk about fiduciary responsibilities those managing public collections have. And I won't even mention the legal responsibilities of records offices. Instead, let's just look at what happens to collections under different conditions.

Anyone even remotely familiar with preservation has been told how bad heat and humidity are to paper collections. And probably many of you have gone through mold outbreaks. You realize that paper is a hygroscopic material. A few of you who have gone to preservation workshops in the past have certainly heard that heat speeds the chemical reactions by which acid destroys the cellulose fibers in paper and bindings. You recall that the presence of water in the air accelerates the chemical reactions even more. High relative humidities will cause the paper to become pulpy and cause vellum to become distorted. You may also realize that as temperature and relative humidity increase, so too will your chances of pest infestations.

The problem with these approaches, however, is that they are difficult to quantify. How bad is 60% relative humidity, as compared to 50%? And is 75°F really that much worse than 68°F? And how do you convince a county administrator, or college dean, that keeping the air conditioning on overnight is worth the cost?

Let's assume, for the moment, that your collection consists of nineteenth and early twentieth century papers — things that are acidic and have, relatively speaking, a short life span. For the sake of our discussion, let's say the paper will last, at 50% relative humidity, 100 years. By increasing the relative humidity to 60%, but holding the temperature constant, what is the affect? Given the recent research, I can tell you that the paper will now last only about 85 years.

And what of the example where the temperature is increased from 68° to 75°? Assuming that we hold the relative humidity constant, this change reduces the life expectancy of our paper from 100 years to only 40 years. The situation gets worse if we are dealing with poor quality paper to begin with, such as newsprint. Under the best circumstances the life expectancy may be only 30 years. Increasing the temperature as little as 7° can reduce that life to only 4 years!

Some, perhaps even many of you, have heard of this research by Don Sebera. Called "isoperms," they provide a tool to help quantify your environmental decisions. It helps you understand the effect of environmental factors like temperature and relative humidity on the useful life expectancy of paper-based collections.

This technique is one that more institutions should be using to evaluate their collection storage conditions. The complete report, *Isoperms: An Environmental Management Tool*, is available for only $10 from The Commission on Preservation and Access. But, until you have a chance to look at it in depth, its helpful to understand a little bit more about the concept. For example, what does the value of 1.0 on the graph mean? It's really pretty simple. All of the temperature and relative humidity pairs along that line will yield the same level of permanence. In other words, 72°F and 30% RH will preserve paper as well as 66°F and 62% RH — assuming, of course, that all other factors are equal.

As you move to the left, toward those lines numbered 2, 3, 5, 10, 25, and so on, you are increasing the permanence of paper. Those combinations of temperature and humidity falling on the 10 line (for example, 49°F and 50%) will preserve paper 10 times as long as conditions falling on the 1 line (for example, the 66°F and 62% RH we spoke of a moment ago). If we are speaking of a newspaper collection whose life span at 1 might be 20 years, we have now increased that life span to 20 times 10, or 200 years. If the collection was acid free paper with a life expectancy along the 1 line of 200 years, we have now increased its life span to 200 times 10, or 2,000 years.

Conversely, if we move to the right on the isoperm chart, then we are facing conditions which will decrease the expected life span of the collection. Moving from the 1 line to the 0.33 line means that the collection will last only a third as long. A 20 year paper will now last only 20 times 0.33 or 6.6 years.

Now, with this all said, lets understand that there are some places on the isoperm chart we *don't want to go*. For example, we rule out the levels above 65% relative humidity because we know the risk of mold at these levels is extraordinary. And we rule out those relative humidity levels below 20% because we know that paper is too brittle in that range.

It's also interesting to take a very quick jab, I mean look, at the levels used by many architects and engineers to plan environmental conditions in buildings. When we compare the ASHRAE human comfort zone with the isoperm chart, we can quickly see that nearly two-thirds of the potential comfort settings are below our preservation threshold line of 1. In other words, designing for human comfort, most of time, will result in premature aging and deterioration of collections.

Isoperms can also help us evaluate set points and tolerance limits. For example, a set point of 70°F ± 5° and 55% RH ±5% covers isoperms from about 1.5 to 0.4. Its possible that much of the time the system would be operating in ranges that are less than ideal. Reducing the relative humidity set point by 5% would improve the situation, as would reducing the temperature set point by even a few degrees.

The isoperm concept is also excellent to help us understand how, if necessary, the temperature and humidity in our buildings should fluctuate seasonally. Lets imagine a set point of 68°F and 50% RH, with annual cycling of ±8° and ±20% RH. In other words, in the summer we would be looking at conditions of 76°F and 70% RH, while in the winter the conditions would be 60°F and 30% RH. Believe it or not, I have actually seen some institutions that would fit this scenario.

The winter isoperm is 4.3, while the summer isoperm is 0.29. There are essentially three means of fluctuating between these two points. One is a straight-line fluctuation. You can readily see that although slightly more time is spent left of the 1 isoperm, the difference is relatively small — there is about equal time under "good" and "bad" conditions. Another scenario is to hold the RH as constant as possible and allow the temperature to fluctuate. This puts most of the transition to the right of the 1 isoperm — in an area of extensive collection damage. In contrast, if we hold the temperature as constant as possible and allow the relative humidity to fluctuate then we see that most of the collection's life is spent to the left of the 1 isoperm — in an area of higher preservation potential.

The isoperm chart helps us to make the best of a bad situation — please do not misunderstand and think I am saying that wide fluctuations are acceptable — they aren't and we should do everything possible to minimize or eliminate them. But if they occur, use of this technique at least helps us understand how to deal with them effectively.

Now also understand that a week in good conditions can't make up for, or off-set, a week or even a day under poor conditions. Environmental affects are cumulative and once exposed to poor conditions there is nothing we can do to "rejuvenate" a collection. That's why its so important to prevent bad environmental conditions to begin with.

A modification of isoperms is the concept of a preservation index, as well as a time-weighted preservation index to evaluate cumulative effect, over time, of changing temperature and relative humidity conditions. The preservation index, which assumes constant temperature and humidity, is the easiest to understand. The chart reveals that storage conditions of 57°F and 50% will have a PI of 95 years. This means that under these stable conditions it will take about 95 years for that collection to degrade — it might be marginally useful, something like brittle newspaper can still be read, but it can hardly be considered a productive research tool.

Time weighted averages take into account that bad conditions cannot be mitigated by periods of good conditions. We can't, in other words, simply average preservation index values to get a time weighted value — the math is a little more complex since the reciprocals of life expectancy are averaged, not the life expectancy values themselves. For those interested in this technique, again The Commission on Preservation and Access will send you a copy of *New Tools for Preservation: Assessing Long-Term Environmental Effects on Library and Archives Collections* for only $10.

Having discussed paper, its important to also mention that the Image Permanence Institute has developed a very similar device — a storage guide for acetate film. For example, we can determine that film stored at 72°F and 50% has an effective life of about 35 years. At 75°F and 60% RH we have reduced the life to 20 years.

It's reassuring to realize that when we look at these three techniques we find that they all project very similar rates of deterioration. Even though we have different researchers using different approaches to different types of material, all come up with almost surprisingly similar results. But this is good, since it gives us even more assurance that when we use one of the various techniques to project life span, we're probably pretty darn close.

Armed with this kind of information, we are in a much better position to explain to administrators, physical plant directors, and deans why environmental controls are so essential. We are in a position to provide simple, yet very accurate, graphs (complete with detailed scientific data) to support our contentions that conditions in the facility are not only damaging the collections, but are having a real, bottom-line, dollars-and-cents impact on a capital investment — our library collection. We have the tools to take the discussion from the level of "this high temperature and stagnant air is really bad for our books" to "these conditions of 82°F and 65%RH are reducing the life expectancy of our collection by about 85% — collections that would be lasting 100 years will now last only 15 years." And this, of course, can be translated into budget increases, cost of replacement, additional staff to order, catalog, and shelve collections, as well as added costs for rebinding collections temporarily and increased costs in other repairs.

But What About Standards?

So, now we not only know why preservation is important, but can intelligently argue the case, at least in relative terms. I am still, however, asked, "So, what should I tell my physical plant — what should the temperature and relative humidity be in my storage area?" While the person asking the question may not realize it, what they are actually asking is, "What should I establish as the set point for my environmental control program?"

For about five years I have been answering that question with a question — "Well, how important is your collection and how long do you want it to last?" Let's be honest, if we are dealing with a branch library with a largely transitory collection we probably should be willing to accept very different environmental standards than if we are dealing with a research library collection, or archival collection.

In other words, to understand the elusive concept of standards you must understand your collections and its value. Will people want your collections, or will those collections be important, in 100 years? If so they need a substantially higher level of care than the circulating fiction books at a branch library that will probably have little redeeming interest 10 years from now.

That doesn't mean we should abuse our public library collections. Every extra circulation is postponement of replacement. Yet, clearly we must be flexible. That is the key to workable standards.

I also advocate a very different standard for new construction than I do when trying to get a pre-existing system to work or solve a mold outbreak. There is a tremendous difference between designing a system appropriate to one's needs and beating an inappropriate system into some semblance of submission.

So, if we're talking about new construction our standard should be appropriate for our collection. We should consider providing our architect with an isoperm chart and explaining that any set point and associated operating parameters to the left of a particular isoperm line will be acceptable, assuming it provides some facsimile of human comfort. You'll notice that I believe staff and patron comfort should come second to the collection. After all, you can wear a sweater or change to short sleeves, the collection can do neither.

Under these circumstances, we are probably looking at a set point of somewhere around 45±5%RH and 67°±2°F. The set point would provide us with an isoperm of about 1.2 and a PI value of about 57 years. To really do much better we find ourselves significantly outside the realm of human comfort and our architect will already be telling us how expensive the system we want will be to operate. Well, as I've said before, preservation costs and there are ways of reducing the operating cost, and, in fact, there is even some data that suggests set points in this range may, long-term, be less costly and more healthy to people, than those closer to the ASHRAE comfort zone.

Nevertheless, there is room for negotiating. And the biggest negotiating factor is segregating collections from staff offices and patron use areas. In other words, design two systems — one for people, where collections will spend very little of their time, and other for the collections, where people need be for only brief periods. In such a situation you can ensure that the collections get the climate control they need, while reducing human-comfort complaints as well as reducing long-term operating costs. Of course, there will be an increase in short-term or initial costs since you will likely need components for two systems. But even this has a significant up-side since with proper design it provides redundancy. If one compressor or chiller goes out, you may lose your fine control, but you don't need to lose everything.

Now, if we are talking about applying a standard to an existing system the approach is a little different. In such a case we should provide our mechanical engineer with an isoperm chart and explain that we need to be as close to the 1 line as he or she can get us, within the constraints of available money. If we can't get over the line all the time, then we should go on and explain that any fluctuations should be such that we stay as close to the 1 line as possible, for as long as possible.

In essence, we are recognizing that a pre-existing system probably can't achieve what our collection needs, and deserves, so we'll have to accept whatever we can get. Improving on that will then be left up to tricks of the preservation trade — such as increasing ventilation and using protective enclosures as buffers.

Understanding Temperature and Humidity

I've focused on temperature and humidity — they are the "meat and potatoes" of preservation and its important to understand not only how they affect collections, but also how they are controlled by HVAC systems. This, in turn, means understanding how temperature and humidity are interconnected and how systems work.

As unpalatable as it seems, if you can't understand the technology you are doomed living forever in the shadow of "THEY" — you know, "they" say it can't be done, "they" say its too expensive, "they" say it isn't necessary. If ever there was truth in the statement that "knowledge is power," it is here. My goal, however, isn't to make you experts in HVAC, but rather to provide you with a brief introduction — enough to help you get started.

First, understand that we are speaking about *relative* humidity. When we speak of 40% RH we are speaking of the percent of moisture that the air could hold, at a given temperature, if saturated. We are not talking about *specific* humidity, or the actual amount of moisture in the air. Consequently, temperature and relative humidity, for all practical purposes, are inter-connected. You can't generally tinker with one, without affecting the other. In other words, if the temperature is 70°F and the relatively humidity is 50%, by increasing the temperature to 75°F, we will drop the relative humidity to about 42%. As the air is warmed it can hold more moisture. Assuming we don't allow any more moisture to be introduced, the relative humidity drops. Naturally, if we dropped the temperature from 70° to 65°, we would find that our relative humidity would jump from 50% to nearly 60%.

This helps explain why tinkering with an HVAC system is rarely a good idea. I have frequently heard offers from physical plant personnel to deal with humidity problems by raising (or lowering) the temperature. But taking advantage of the natural physics of air and moisture is rarely adequate to deal with root problems.

More often what we need is to either dehumidify or humidify the air — either taking water out or adding water, all the while holding the temperature (more or less) constant. Consequently, its important to understand how an HVAC system goes about controlling humidity.

Let's start with a very simple, basic HVAC system — something on a very small scale. For example, something we might find in an apartment or even a small commercial building. These are typically called packaged DX or direct expansion systems. They cool the air by passing it over coils that are filled with a coolant which absorbs the heat from the air. This usually draws off some water from the air, since cool air can't hold as much moisture as warm air. The water is caught below the coils in a condensate pan that is usually piped outside. This is also the slow drip you see from a window air conditioner or occasionally from so-called central air conditioners. The warmed coolant is also piped outside to the condenser, where a fan is used to again cool the pressurized gas to a liquid, and the process is repeated. Included in this system, of course, would be some form of filtration, but we'll talk about that in a minute.

Even huge institutional systems are essentially the same. A chiller may provide chilled water for the coolant, a cooling tower may be used instead of a condenser to dispel the absorbed heat, and a boiler may be used instead of electricity to provide heat, but the principals are the same. The only issue I would throw at you for larger systems is, as I mentioned earlier, the need for redundancy. Although equipment well installed and cared for with a preventative maintenance program will have life expectancies of 30 years, failures do occur. When the system goes down, there should be redundancy, especially in chillers and boilers, to provide some buffering potential.

Very simple air conditioning systems are pretty good at cooling, but really don't do a very good job at dehumidifying. Although some moisture is driven off (lowering the specific humidity), the amount is relatively small since we aren't cooling the air all that much. If we tried to drive off more moisture by dropping the temperature of the coils, we would end up dumping a lot of very cold air in the space we're trying to condition and probably get complaints from the occupants.

In addition, if we were to measure the relative humidity of the cooled air right off the coils, we'd find that it is near saturation — as much water as possible was driven off, leaving the air, at the temperature resulting from the cooling, fully loaded with moisture. This air is then mixed with the air in the rest of the space we're cooling and this mixing results in a slight lowering of the relative humidity. Why? Well, as the air is warmed it doesn't contain as much moisture as it can hold, so the relative humidity is slightly lower. Nevertheless, this isn't particularly efficient and it certainly isn't appropriate for collections.

What this system needs is something called reheat. These are heating coils which are installed in the airflow just past the cooling coils. With these in place and operable, what we can now do is reduce the temperature of the cooling coils far lower than before, driving off much larger quantities of moisture or specific humidity. The very cold air, which is at or near to saturation, is then passed over the reheat coils. There the air is heated up and this reduces the relative humidity of the air. The dehumidified air is then dumped back into the space.

Reheat can be provided by electric heat or by hot water piped through coils. Occasionally you'll find systems with reheat where the reheat as been turned off in order to, guess what, save money. And money *is* saved, but the collections at put at risk. More often, however, you'll find systems designed with either no reheat, or inadequate reheat, because the engineer didn't realize the importance, or complexity, of dehumidification in a library setting.

Reheat often can be added to existing systems. In addition, it is often possible to obtain better dehumidification by replacing coil assemblies. Sometimes even cleaning the coils can make a difference in performance.

One tremendous difference between libraries and normal buildings is that libraries have very little heat load. That is, there isn't much in a library or collection storage area that generates heat. Even the fluorescent lamps, that can usually be counted on to produce some heat, are turned off in closed stacks. There are relatively few people in libraries, at least on a per square foot basis, since most of the space is taken up with ranges or other forms of storage. The heat in "normal" buildings is counted on to lower the relative humidity of the air passed over the cooling coils — in essence to provide something like free reheat. But this doesn't happen in libraries, archives, and museums. This is also why a lot of institutions who have bought Liebert units are disappointed in their performance. Lieberts are typically designed for computer rooms, where a lot of heat is generated. Therefore they have relatively limited reheat capability and often don't dehumidify as well as collection managers think they ought to.

Dehumidification can also be achieved using desiccants. Many of you may be familiar with the use of desiccant wheels which slowly revolve in the air stream collecting moisture and then expelling that moisture during a heating cycle. One of the foremost manufacturers is Munters. There was a time when desiccant dehumidification wasn't thought appropriate for collections. Not only were the systems large and difficult to operate, but there was concern that the abrasive desiccant could enter the air stream. These concerns are things of the past and desiccant systems are used in clean room settings, as well as schools and grocery stores.

In addition to the desiccant wheels, there are also liquid desiccants such as those manufactured by Kathabar. These have the added benefit of the liquid being able to remove and kill over 90% of all bacteria, viruses, and molds. While this sounds like it would be out the reach for libraries, museums, and archives, these systems are actually more energy efficient than the wheels and are usually easier to operate.

There is yet one more system worthy of brief mention. Heat pipes are another form of reheat, although it is significantly less costly to operate than traditional reheat. The warm to hot outside air is passed over special metal pipes that are particularly designed to pick up and transfer the heat — hence they are called heat pipes. This heat is then transferred to the air downstream of the cooling coils, where it serves to reheat the overcooled air. In essence, cheap reheat. One of the primary manufacturers is Heat Pipe Technology — a fairly easy name to remember. They produce packaged dehumidifiers using this technology that can be put into new systems or used as ad-ons to existing systems.

The point here is simple, dehumidification must be achieved by either reheat or by desiccants. We can't get enough dehumidification using simple coils and nothing else. In just plain won't work — don't believe what anyone tells you.

Even in the South we occasionally need to add moisture to the air, most notably in the winter when the building is heated. There are a number of options for humidification, but the best option is to have steam humidification *in each zone* of your building. Devices which provide humidity by spraying water or which introduce water into the system as a liquid, rather than steam, should be avoided. Not only do water systems tend to have higher maintenance and greater potential for harboring mold, bacteria, and viruses, but they are more likely if they fail to wet collections. The zoned approach is critical since it is likely that different areas will require different levels of humidification. Humidification steam should be clean — it should not come from the boiler, since they have a number of chemicals added to them to control pipe corrosion. These chemicals, which tend to be alkaline, should not be put into the air as aerosols. They are both unhealthy and also damaging to collections. So, the appropriate technique is to require a steam generator using deionized water, although this generator itself can be heated by boiler water.

Humidification, however, requires that you have humidity-tolerant building envelope. Otherwise, as you add moisture to the air, you will find it condensing on the cooler walls, ceilings, and windows. This, in turn, will likely cause significant structural damage, especially if the moisture condenses between the inner and outer walls. For some reason too many architects, and almost all contractors, act as though vapor barriers are code words in some foreign tongue. They are rarely designed appropriately, and when they are, the contractor seems determined to ignore their placement or to put so many holes in them they look like confetti afterwards.

In addition, its essential that humidification systems have sensors to detect if the space, or duct work, is being over humidified. These sensors should warn of the water problem and shut the system down.

And this is also probably a good time to mention that when we have water running over collections, as either steam pipes, or condensate lines, or cold water for cooling coils, sooner or later there will be a problem — especially if your institution relies on deferred maintenance. From a design perspective the only water pipes I would allow over a collection are pipes for a sprinkler system — there the benefits far outweigh the very minimal risk. Other piping, however, should be routed in non-collection areas. And all cold water pipes must be insulated. Without insulation condensation will form and these pipes will drip, just like there is a leak.

No excuses, no trying to cut corners. If you're in a building where pipes are already present overhead, then invest in water detection devices to minimize the inevitable damage and plan ahead, stockpiling plastic sheets and blotting paper.

What are Other HVAC Concerns?

Temperature and humidity are only the beginning of our concerns. An HVAC system also consists of appropriate controls — devices which allow adjustment of temperature and humidity. Typically these are pneumatic, using air pressure to adjust or control dampers, valves, and other systems. These are little boxes on the wall that, when adjusted, make a whistling noise a few seconds latter. Pneumatic controls are inexpensive to install, very durable, simple to operate, but they are notoriously inaccurate. Adjustments are required at least annually, and probably more often, perhaps even monthly. And I have never heard of a physical plant staff willing to take the time to make the necessary adjustments on anything approaching a routine basis. Consequently, even a relatively good system can be compromised by inaccurate controls.

There are better devices, called electronic controls. Only slightly more expensive, these devices provide greater accuracy and allow very easy remote control of space conditions. They can also be integrated with direct digital control using computers and software programs to maintain the system. While not suitable for every operation, when appropriate they can provide significant energy savings and extraordinary simplicity combined with very precise control.

Some architects and engineers try to save a few dollars by installing the sensors in return ducts, justifying the decision by noting that this placement provides an average of conditions. Sometimes they will even make it sound like they're doing you a favor. In reality, they're not. We don't want averages of conditions from several spaces, we want the actual conditions within those spaces. So sensors should be mounted in collection storage areas — where your collections actually spend the bulk of their time.

Another major choice that confronts most institutions in the design phase is the choice of either a constant volume system or a variable volume system. In a constant volume system the air handlers provide a constant volume of cool air to the conditioned space. Zone thermostats and humidistats control the reheat to satisfy thermal and humidity demands. But the amount of air is always constant. In VAV or variable air volume systems it is the air flow into the space that is adjusted. Although this saves money, it also places the collection at risk. First and foremost, it is virtually impossible to adequately dehumidify with a VAV system. The increased humidity levels and reduced air flow combine to create a scenario where mold is not just possible, but more often than not, a way of life. In addition, a VAV system does a generally poor job of filtration, since the air volume is often much lower than necessary to remove particulates from the air.

The last energy-savings idea foisted on museums, libraries, and archives by architects and engineers is the air economizer. There are those nice fall and spring days where, especially early in the morning, it is crisp and cool. Of course the relative humidity is often 80%, but you really don't feel it because the air is so cool. Well, an air economizer uses the outside air on such days to provide "free cooling" to the building. Rather than cooling and dehumidifying, the system simply dumps outside air in the building — with no dehumidification and often with little filtration. So, you get free cool air, and then develop mold problems.

Devices like the VAV system and air economizers are perhaps suitable for office buildings where human comfort is the only concern. But, as we discussed earlier, our collections need conditions far superior to ASHRAE's human comfort indices. In addition, office buildings which are typically rental, expect to repaint and re-carpet on a routine basis and this significantly reduces mold levels. Most institutions can't afford this same level of upkeep. I'll also mention that recent studies are beginning to discover that these systems aren't all that good for indoor air quality. In fact, we're slowly realizing that dehumidification in summer and humidification in winter aren't just good for the collections, they're also good for people.

When discussing VAV and CAV systems its important to understand how essential ventilation is to the health of collections. I have seen otherwise well designed systems, capable of providing at least minimal levels of control, that were sabotaged by either poorly designed duct work or by institutions that changed the position of their interior walls or ranges without realizing the impact those changes have on air movement.

Simply put, we have to get the conditioned air to the collections. Otherwise, we create dead spots of high humidity where mold repeatedly occurs — although no one at the institution can understand why.

Proper design of duct work and ventilation rates is as complex as the proper design of dehumidification. It shouldn't be left to chance. Significant deviations from the ductwork design and routes by the mechanical firm can affect the capability of the system to function as designed. Longer duct runs, smaller ducts, and more turns will all increase the static pressure, reducing the amount of air actually distributed through the system. As the flow decreases, so too does the system's ability to heat, cool, humidify, and dehumidify.

The final HVAC issue I need to address is particulate filtration. Most systems have one or two inch fiberglass batt filtration. Now that sounds like quite a bit, especially those two-inch filters. But in reality they provide very little filtration — in fact they are designed primarily to keep the coils from fouling. To catch the big stuff that could really damage the system. They do almost nothing for either patron comfort or the preservation of our collections.

Most of the filters found in air handlers are rated using ASHRAE's test for "arrestrance." This essentially gauges how well a filter will stop the big particles of dust. A 1-inch filter might have an Arrestrance of 70-75%. A 2-inch filter might have an Arrestrance of 80-85%. Sounds pretty good, until you realize that this is catching only the big particles. Virtually all of the smaller particles — those that affect your health and the health of your collection — are flowing right through. These smaller particles are the ones which are collecting on the headcaps of books and providing the beachhead for mold. They are also the particles that create the most soiling, that contain other contaminants, and that can abrade the collection.

What we want to be concerned with is the ASHRAE Dust Spot Efficiency Test, since that is the test which quantifies the small particles. We want, at a minimum, filters that remove at least 50% of particulates using the ASHRAE Dust Spot Efficiency Test. Higher, if you can afford it, is better. Museum storage areas, for example, should have 90-95% ASHRAE Dust Spot Efficiency Test filters.

The relationship of these two becomes clear when you realize that 80% Arrestance equals about 20% Dust Spot Efficiency. Frequently your physical plant will tell you that you have 70-75% efficiency filters, when what they *mean* and what they should be telling you is that you have 70-75% Arrestance filters, providing you with little protection from the particles most damaging to your collections.

<u>What About Gaseous Pollutants?</u>

So far I have been focusing on temperature, humidity, and particulates. What about gaseous pollutants — things like ozone, oxides of nitrogen, and sulfur dioxide? These have a variety of sources, some within the building (like printers and copiers that belch ozone), but many on the outside. Most are by-products of what we call civilization — smog, industrial pollution, auto exhaust. There are also a variety of other pollutants, such as formaldehyde and solvents or VOCs, most of which are found primarily within new buildings and are often associated with new construction. These are the products of "better living through chemistry." And all of these can dramatically affect our collections (not to mention our health).

The normal background concentration of sulfur dioxide is around 6 to 30 ppb, for oxides of nitrogen its 1 to 15 ppb, and for ozone typically under 1 ppb. In urban areas, however, these levels are significantly higher. For example, peak concentrations of sulfur dioxide are around 100 to 750 ppb, oxides of nitrogen are 40 to 100 ppb, and ozone may be at 40 ppb. In fact, in the York County, South Carolina area — just south of Charlotte — ozone peaks at 138 ppb. In rural South Carolina the nitrogen oxide levels are around 20 ppb. And sulfur dioxide in downtown areas is upwards of 110 ppb. So you can see that the levels are very real.

The next question, of course, is at what level are collections affected. We know that outside pollutants can be remarkably buffered from our collection by the building envelope — assuming it is tight and well constructed, and assuming that we aren't relying on an air economizer or dumping large quantities of outside air in our institution, and that our air intake isn't right next to the loading dock where all the trucks allow their motors to idle. Interior construction features, like wall board, act as sinks, absorbing large quantities of pollutants.

But, of course there is a limit, especially if we ar allowing outdoor pollution in, or if we are creating indoor pollution.

You will also hear from many people that such-and-such level is safe, according the EPA or OSHA. For example, Federal standards to protect human health limit sulfur dioxide to 140 ppb, oxides of nitrogen to 53 ppb, and ozone to 120 ppb. But if we think about it, its totally inappropriate to use these to gauge the health of our collections. As living organisms we, thankfully, have the ability to filter out, excrete, and otherwise get rid of a lot of pollutants. When you think about it, the human body is incredibly well-designed. Our collections, however, have no such ability and even low levels — background levels in the low teens — cause damage. Silver tarnishes, the pennies in the dish on your bedside table darken, the pewter mug you put your beer in discolors. These are all visible signs of what these pollutants do. Not so visible are other chemical reactions. Sulfur dioxide and oxides of nitrogen combine with the moisture in the air to form sulfuric acid and nitric acid — both of which aggressively attack paper and bindings. Ozone is a powerful oxidant and it breaks every carbon double bond it comes into contact with. Consequently it can destroy virtually all organic material — textiles, paper, furniture, leather, fur, feathers. It can even increase the oxidation — or tarnishing — of silver and copper.

As a consequence, the current recommendations are that sulfur dioxide be kept below 0.35 ppb, that oxides of nitrogen be kept below 2.65 ppb, and that ozone be kept below 0.94 ppb. As you can gather from our discussions, these are very low levels.

There are filters for gaseous pollutants, but first I encourage institutions to eliminate as many sources of pollution as possible. In the design phase, avoid the air economizer, locate intact ducts where there is no chance of pollution, install good vapor barriers, design the HVAC system to use the smallest amount of outside air approved by your code jurisdiction, and then keep doors and windows closed. Also, design for a pollution free interior. Instruct your architect to use water-based adhesives in lieu of solvents. Use only products with low VOC (volatile organic compounds) emissions. Avoid products that are known to off-gas large quantities of formaldehyde or acetic acid. Where necessary use sealants to trap off-gassing.

Once these steps have been taken, if it is still necessary to further clean the air, then the only reliable approach is the use of a media, typically either activated carbon or potassium permanganate. Both can do very respectable jobs and the only real difference is that carbon can release absorbed contaminates, while potassium permanganate results in a chemical change which binds the pollutants. Another difference is that carbon is black and stays black, regardless of its condition, while potassium permangnate changes color from purple to brown as it is exhausted. Consequently, for most applications potassium permangnate, such as sold by Purafil, is probably preferable.

<u>How Do We Measure Our Problem?</u>

Now we have outlined the horrors of bad environmental conditions, how do we know if there is a problem?

The simplest way is to look around you — use your senses, and examine your institution with a critical eye. Do you see evidence of mold — on books or bindings, on painted walls, on ceiling tiles, in dark storage areas? Do you smell mildew — that smell are the metabolic by-products of mold and it is a sure indication that you have mold somewhere. Do you have areas of your building that are either freezing cold or burning hot? Are there areas that the air seems very heavy and still? Do you have strange, chemical-like smells? Is there a dense collection of dust around the air vents? Could your institution withstand a "white-glove" test? Look at your collections. Is there always dust on the headcaps of your books? Can you write your name on the top of Hollinger boxes? Is the paper brittle? Are vellum bindings warped? If you have wooden objects in your collection, do they evidence cracking or peeling of the veneer? Are glued joints loose? If you have metal objects, are they tarnished, corroded, or pitted?

Although these are not quantitative evaluations, they are an excellent first step. See what you can see. Are your problems worst in one corner of the building or on one floor? Are they more pronounced during a particular season or time of day?

In general, we have become too complacent toward our surroundings. Its essential that we begin to take control — and the first step is understand what is happening around us.

Having sharpened our eyes and taken a decongestant to allow us to sniff out problems, what's the next step? What sort of monitoring equipment should we be using?

Open up just about any book on preservation and it will go through monitoring equipment in excruciating detail — almost like its reciting a mantra. Perhaps that was useful a few years ago, but technology has changed dramatically in the past five years and a lot of what is being said dates from the dark ages.

Let's talk about some equipment for a minute. For spot temperature and relative humidity readings there are cards, hygrometers, sling psychrometers, aspirated psychrometers, digital instruments. Of these, forget hygrometers, and sling and aspirated psychrometers — you don't need them, they aren't that accurate, they're hard to use, and/or chances are someone on your staff will use them wrong. Ten years ago they were state-of-the-art. Occasionally today they are treated like holy grails that provide entrance to the secret society, but they're really only dinosaurs from a previous age. If you're using them, put them out to pasture and join the Twentieth Century.

Now cards aren't bad, they just aren't particularly good. But, at about $6 you're not going to get a cheaper technique. They are like the ceramic hen your grandmother had outside on the back porch — if it was blue it was going to be good weather, if pink it would rain. Well, the technique is still the same — blue and you're ok, pink and you're on your way to massive mold. It's pretty much that simple.

If you're going to use cards, use the cheap ones. Don't get sucked into all the fancy ones with different dots, or that have fancy thermometers, or that have other dials. Low tech is low tech, no matter how you try to make it sexy.

It used to be that digital instruments cost thousands of dollars. Today, you can get an excellent digital instrument from Vaisala for under a thousand and you can get inexpensive instruments for under $500. You do get what you pay for, but let's face it, none of us are checking the RH of the space shuttle. Get what you can afford. And for those who say they can't afford anything, there are fine digital instruments that offer minimum and maximum temperature and RH readings for under $65. They aren't just available from conservation catalogs like Light Impressions and University Products, they are now even available at Radio Shack — for under $30! Now no institution has the excuse of saying they can't afford an instrument.

Those instruments with the minimum and maximum readings not only tell you what the current conditions are — which you can monitor hourly if you want some even come with a clock — but you can even check what the variation was overnight or over the weekend when your building was closed. You can now get some good idea of what variations your collection are faced with — for under $30.

Don't let those physical plant bullies come in and laugh at your instrument. Assuming you haven't dropped it on the floor, it will be pretty darn close. After having mine for nearly five years, traveling with it all over the country, and using it in 30 or more workshops, its within 2° of being on the "right" temperature and 4% of being on the "right" relative humidity. And frankly, we don't need better accuracy than that.

If we're searching for a recording instrument we are still faced with either a recording hygrothermograph or a data logger. Low tech or high tech, both cost about the same. Hygrothermographs have pretty well stabilized in price, while data loggers face stiff competition and their prices are coming down.

For those going toward hygrothermographs, avoid spring wound models, those with ink pens, and those relying on human hair elements. An excellent model is that offered by Omega. Using AC power, it has DC power backup in case of power outage. It has a sensor on a 6-foot cord. It has programmable alarms. It indicates power outages on the graph, so they can be correlated with environmental changes. And, perhaps best of all, Omega stands behind their equipment, offering free repair or replacement of damaged units. You can't beat the deal.

Many people like data loggers. They automatically monitor temperature and humidity at user-established intervals, recording the data internally for eventual download to a PC or Mac. With many you can place them and forget about them for several months, so there is no more weekly chart changing. Once downloaded the data can be "manipulated" to produce all sorts of sexy charts and graphs. The downside is that there is no immediate gratification — you can't look at them at tell what's happening right now. Another problem is that associated with any computer technology — it doesn't always work and you can lose data. I'm sure all of us have had that experience with computers. If you are inclined toward a data logger, shop hard. There are a number of different manufacturers beyond those advertising (at generally higher prices) in conservation catalogs.

Monitoring of particulates is much more difficult, or perhaps I should say expensive. In general, the requirement is that particulates weight less than 75 micrograms per cubic meter (expressed as 75 $\mu g/m^3$). There are instruments which can measure particulates. Some can be connected to the air stream directly, while others are portable. They measure concentrations ranging from 0.001 to 1000 $\mu g/m^3$. MIE's models cost from $2,500 to $3,500.

Not only will these probably not be in your budget, but I'll go one step further and tell you that you probably don't need them. Look around — do you see dust? If so, you have a problem. Find out what kind of filters you have. If you don't have at least a 50% Dust Spot Efficiency filter, you have a problem. Spend your money on the problem, not on the testing.

Monitoring gaseous pollutants present the same problems. Accurate monitors for very low levels of ozone, sulfur dioxide, and oxides of nitrogen exist, but typically cost upwards of $6-10,000. Consequently, I generally recommend that institutions use a different approach.

One is a completely qualitative test, using strips impregnated with potassium permangnate. As these strips are exposed to pollutants they change from purple to brown. This provides an excellent visual indication of some kind of problem. They can be used inside display or storage cases to judge off-gassing.

They can be used adjacent to doorways to gauge the amount of pollutants coming inside. They can be hung by air vents to evaluate the amount of pollutants being distributed through the system. They can even be placed inside of Hollinger boxes to better understand the buffering effects of the enclosure. These strips, available from Purafil, are very inexpensive — $50 for 25 strips, each of which is perforated so the color can be evaluated over time.

Another approach uses metallic coupons, also available from Purafil. These coupons are exposed to the air being studied for a set period of time. They are then packaged up and sent back to Purafil, where the amount of corrosion is evaluated. Although the data is reported in amount of corrosion, rather than levels of different chemicals, this nevertheless provides us with a semi-quantitative analysis of the environment. Like the strips, these coupons can be used just about anywhere. Each coupon bank comes with six coupons. Two coupon banks are available for only $500, or less than $50 per test.

Although the strips are substantially less expensive, I would encourage institutions to move from one to the other as they better understand where areas of gaseous pollution may be affecting collections. In other words, use the strips widely to evaluate different areas of your building. Then use the coupons in the best and worst of those locations in order to better understand the severity of the problem. The coupon data will also provide the type of information necessary to design an appropriate filtration system.

I suppose this naturally leads to an important issue. Far too many institutions monitor — temperature, humidity, light, whatever — with no real idea why they are monitoring, no clear goal for the monitoring program, and no real commitment to change. For example, I know one very large museum which has been monitoring an absolutely atrocious environment for nearly six years, but has made absolutely no effort to improve the conditions — in spite of two consultant reports identifying the exact same problems.

Monitoring is a tool, it is a means to an end — *it should never be considered an end, in and of itself*. If you suspect a problem design and implement a monitoring program. Collect the information necessary to make changes. While monitoring align your forces to successfully deal with that problem. Afterwards, monitor on a reduced frequency to ensure success and that there are no new problems. But please, don't just monitor to prove how bad things are, with no real intention of making improvements. Spend your time in a more productive activity.

But What Do Small Institutions Do?

Confronted with all of this information, I'm willing to bet that there are more than a few of you who are ready to turn me off. You're probably claiming that these standards are impossible to meet. You live in the real world of a less than appropriate building and no real chance, at least anytime in the near future, of getting a better building.

I speak to librarians, archivists, and curators in that position all the time. As a consultant my goal is to take an impossible situation and make it a little more bearable. While I love to work in the ideal, I spend a lot of time in the real world striving to make small improvements.

I'll remind you of what I said at the beginning. Preservation costs money. There is no silver bullet. There is no way to turn a totally inappropriate building into a well-designed show-case. Every institution here likely needs to spend more money caring for its collections and less money adding more collections. We need to accept that preservation is a cost of doing business.

Nevertheless, there are options.

In terms of temperature and humidity, begin with your building. High and/or fluctuating humidity levels often mean that there is a failure in the building envelope. A roof may need replacing. You may need to install sweeps on doors. Gutters may be clogged and be introducing moisture through the walls. Sprinklers outside may be hitting your foundation. Trees may be overhanging your building and delaying drying. Look for maintenance improvements. Especially inquire if your institution has adopted a deferred maintenance program. Your problem may lie not entirely with the system, but the maintenance of your facilities may be contributing.

Look also at how well your HVAC system is being maintained. Does your institution, for example, have a preventative maintenance service contract? Perhaps you need an outside contractor to come in and evaluate if the system is performing to its peak potential?

I caution you, however, to avoid the tweaking or tinkering approach to HVAC maintenance. This involves making multiple adjustments in the hope that something will help improve the situation. Usually the tinkering only makes matters worse, but even if there is an improvement, its usually impossible to determine, among all the things done, what was significant. An active water leak requires immediate attention. A poorly performing HVAC system requires study and evaluation. Avoid the temptation to "do something, even if its wrong."

While not a permanent solution, you will likely find improvement for localized problems by using industrial fans. Please, avoid the use of cheap fans — you know the ones I'm talking about. They're under $20, made of plastic, and guaranteed to burn your house down if operated for more than three continuous hours. If you need ventilation, you need it for long periods of time and you'll probably need to leave it unattended. Purchase high velocity fans — look for upwards of 6,000 to 10,000 cfm. These will move enough air in collection storage areas to make a real difference. Be sure that they are properly grounded and that you don't use extension cords.

Dehumidifiers can be a useful, short- or moderate-term solution, although I discourage them as a final, or long-term solution. Keep in mind that this is another area where size matters. A typical consumer model dehumidifier is usually rated between 25 and 30 pints or about 3 to 4 gallons, meaning that in a 24-hour period that is the maximum amount of water it can pull out of the air. Under high moisture conditions this is enough for about 1,000 to 1,500 square feet — if the entire area is open and there is good air circulation. Otherwise, performance will be dramatically reduced. Consumer models are also not meant for rugged, continuous operation. Under that sort of stress, they typically have a life span of four or five years.

If you have a serious enough problem to warrant a portable dehumidifier, you should seriously consider an industrial quality model. A company such as Ebac Systems produces dehumidifiers with capacities of 13 to 28 gallons per 24 hours. These also frequently have automatic pump-outs, capable of pumping the condensate for considerable distances to drains — an essential feature for continuous operation.

One of the best steps you can take to help deal with particulates is to reduce the load of "dust" within the building. Install better, and longer, runners outside to remove more debris from patrons shoes. Implement a more aggressive housekeeping program. Tile or wood floors should be damp mopped daily, with high traffic areas perhaps even more frequently. Avoid the use of carpet — its difficult to clean, is a reservoir for moisture and mold, and adds large quantities of particulates into the air as the fibers break down. If you have carpet, recognize that you need to vacuum them several times a week, depending on traffic.

Weekly cleaning, that so many institutions have gotten used to, simply won't deal with the large quantities of particulates introduced into building with poor filtration systems.

In addition, have you ever noticed that when you vacuum at home, in front of a window with light streaming through, that there is this cloud of dust around you? Most vacuums are pretty good at getting the big hunks of debris, but otherwise simply redistribute the fine dust to give you the impression of cleaning. Take a look at Consumer Report's evaluation of vacuums. At the very least insist that your housekeeping staff use one of the top three for dust retention. Many of these can even be improved by using a better bag — one that retains more of the small particles. These bags, while costing more, can be widely purchased.

Better still is a HEPA vacuum. These have filters designed to trap 99.5 of the particles down to 1 micron in size. These are the small particles that are particularly damaging to collections — as well as people. HEPA vacuums are also coming down in price, with small portable models now at about $600, while larger ones are about $1,300. While it may sound like a lot of money, it will be one of your best housekeeping investments ever. And it is absolutely essential if you anticipate treating a mold outbreak.

Also remember that you can deal with small collection spaces using, in essence, spot treatments. For example, for records storage vaults or special collections you might consider using one or more HEPA air filters. While these typically have a fairly low movement of air, they include a HEPA filter and often a charcoal prefilter. Just remember to change the charcoal prefilter at least monthly.

If you are at a branch library or historic site with a small HVAC system, you may discover that you can replace your current fiberglass filters with a high-efficiency filter. Although it may only provide 30% ASHRAE Arrestance, it will still be far better than what you're currently using. Just verify with your HVAC company that the existing fan motor can accommodate the additional resistance of the new filter.

Also, ensure that the filters you do have are being changed as they should. Here's a little trick. Ask your physical plant how often they change the filters. I'll wager that most respond with something like, "every six months," or worse, "when they're dirty." Both answers are probably wrong.

Filter life can really only be judged by the drop in pressure across their face as they become "dirty" or clogged with debris. And the only way to determine this pressure drop is for the air handler to be fitted with an manometer or mangehelic gauge. Most architects and engineers leave off these essential items, even though they cost only $20 or $30. Not only will they tell you when filters need to be replaced, but they will also prevent you from wasting money by replacing filters before their time.

Now gaseous pollutants are a little more difficult to deal with. Keeping your building closed will help. You should also eliminate, or segregate, pollution sources inside the building. Smoking should be eliminated. Copiers should be housed together and vented outside. Printers should be isolated from collections. Repair work and even maintenance activities should only use low VOC products. Also helpful, at least in small areas, are the charcoal prefilters on portable HEPA air filters. And there are even some companies, such as Cameron-Yakima, that produce replacement filters impregnated with potassium permangnate or charcoal.

Beyond these suggestions, another valuable tool is buffering the collection. Creating a barrier between the collection and the problem — be it temperature, humidity, dust, or gaseous pollutants. This buffering approach is great for museums and archives, although it is admittedly difficult for circulating collections.

One of the most common barriers in archives, records centers, and special collections are the boxes materials are stored in. Hopefully they are minimally pH neutral and have an alkaline buffer. The better products are also lig-free and ground-wood free. These containers offer an exceptional buffer between the harsh world around them and the papers within them. My only caution is that even the best storage materials, over time, will exhaust their buffering capability and become acidic. This happen, obviously, much more quickly under adverse storage conditions. So, don't assume that appropriate housing is a once-in-a-lifetime undertaking. Periodically take your pH pen to your boxes and folders. Replace those that have failed.

Over the past five years the number of products has dramatically increased. For example, Masterpack offers a variety of barrier products, especially Nomex and Nomex-Mylar. These two products slow rapid changes in humidity, help protect against off-gassing of compounds like formaldehyde, are mold resistant, resist penetration by dust and other particles, and are themselves free of chemical additives. They can be used to line display and packing cases, can be used as liners on shelves, and might even be appropriate for other uses, such as lining the interior of vaults or special collection rooms to better isolate them and create "rooms-within-rooms."

Conservation Resources, several years ago, introduced what they called Microchamber Products. These are typical folders, boxes, and other enclosures with specially activated carbons or molecular sieves that buffer out gaseous pollutants. Although these products are modestly more expensive, the test results reveal a dramatic improvement in storage conditions. The Metropolitan Museum of Art has also tested Conservation Resources' Microchamber Board for use as a scavenger in display cases, finding that it performed well for silver, but not particularly well for copper or lead. On the other hand, Conservation Resources' Microchamber Emulsion Paint-on Preservation did well for silver, copper, and lead. Consequently, it may be appropriate for a variety of special settings in libraries and archives.

For those with metal, I should also note that Conservation Resources offers several tarnish inhibitors. These are volatile corrosion inhibitors that create a protective barrier around ferrous and non-ferrous metals. For silver collections, the use of Springs Industries' Pacific Silvercloth is another appropriate material for the creation of a micro-environment. The fabric is impregnated with silver nitrite which absorbs pollutants, effectively tying them up before they can reach the silver being protected.

Also newly introduced into the preservation market are corrosion intercept bags. Polyethylene is blended with reactive polymers and solid-state additives, typically copper, and formed into bags, tubes, sheets, or even trays. The additives react with corrosive pollutants and thus prevent their penetration through the polymer by neutralizing them. Through time the copper color is transformed to a black color, indicating that the material is at the end of its serviceable life. This material provides protection from sulfur and other compounds.

A Preservationist's Perspective on Working with Architects

This is a good place to also briefly turn our attention to working with architects. Perhaps you're planning a new building. Or perhaps a renovation. Maybe you are also thinking of "adding-on." Whatever the case, be forewarned.

The old joke is that the worst enemy of libraries and archives are patrons dog earring collections, incorrectly handling books, and misfiling papers in folders. From the preservationist's perspective, the worse enemy of museums, libraries, and archives are the architects that design them and the contractors who build them.

But let's be fair, museums, libraries, and archives comprise a very small percentage of an architect's design time or a contractor's pay roll. Even those architects who specialize in these buildings typically do only a very few, relatively speaking. And they aren't always done that well.

In general, architects come into the facility and confront a confused and poorly organized team. Politics is rampant and often there is no clear organization or philosophy. More times than not, preservation isn't even mentioned as one of the top three concerns. When it is discussed, its often far too late in the design phase to be meaningfully integrated. Or worse, its couched in such ambiguous terms that's it pretty well unintelligible. For example, "we want good temperature and humidity control," when you 9+get down to it, doesn't really mean much. How good is good, at what level, for what parts of the building. And most important of all — are you willing to pay for it?

In other words, institutions are as often to blame for disastrous designs as the architect.

Now, I can offer some simple ideas on working with architects that I hope everyone will listen to carefully. They may save you thousands of dollars and are worth the price of admission alone. I've distilled them to 10 essentials.

First, hire a preservation consultant to work as an intermediary between your team and the architect. This will save you time, frustration, and ambiguity. The $2,500 or $5,000 you spend will be paid back many times over when you have a building that works to preserve, not destroy, your collections.

Second, pay as much attention to hiring a good engineer as to a good architect. While engineering may not be nearly as sexy as design, it is the bread and butter of preservation success. You can't see the vapor barrier, or the HVAC system, or the fire detection/suppression system, but as a preservationist they are what you are buying when it comes to A+E services, not how pretty the building looks.

Third, make sure that your architect and engineer understand the different needs of a library, archives, or museum. Make sure they understand the heightened expectations regarding temperature and humidity control; that superior filtration is essential; that fire protection must exceed, not just comply, with the code; that there will be little load most of the time; and so forth.

Fourth, understand that preservation costs, even in the design phase. Its harder to design the type of building you need than it is to design an office building or a supermarket. Expect to pay for the expertise you expect your architect and engineer to possess.

Fifth, be wary of "saving energy." Typically this means creating something far short of a preservation environment. Reheat for dehumidification and heating humidification steam are two examples of the so-called "wasted" energy that are essential to a preservation environment. VAV and air-economizers are examples of energy-saving features that will doom your collection to a life of mold and misery.

Sixth, review and understand each design. I can't begin to tell you how often I've sat down with a client and a set of design plans and found that they had no idea of what was happening. One client failed to notice that the fire suppression system had been deleted from half of the building — the collection storage area — to save money, since it wasn't required by code. Another never realized that the engineer had designed in a VAV system for the collection storage area. Ask questions and demand reasonable, intelligible answers. Ask questions about issues we've raised today: "Tell me about the vapor barrier you're designing for our building," or "tell me about water control in the building — where exactly will the water piping be located?"

Seventh, budget cuts are a given. Every institution wants too much and is forced, eventually, to be realistic. Too often, however, what's cut back are the very items that will ensure the preservation of the collection. No one looks in HVAC rooms, or notices fire suppression, or can see the vapor barrier behind the wall, so these are the features that are scratched. Be vigilant and be prepared. Constantly go back to your mission statement — that part about preserving your collections for future generations. Also, insist that your architect and your institution review costs not simply as initial costs, but life-cycle costs. In other words, a little money now may well save you thousands during the life of the equipment or building. Plan for the long-haul, not the next year.

Eighth, understand the construction process. Realize, for example, that when an architect specifies a particular product, "or equivalent," its the bidder that decides if another item is an equivalent. This can result in some pretty frightening replacements. If you want your architect to certify that "equivalents" are actually equal, you have to pay him or her to do so. Likewise, understand that your architect isn't an inspector. He or she will be on site a few times during construction, but if you want the architect to stand guard over the contractor, that's additional billable time. Also, insist on as-built plans, but realize that they, too, will cost more. Understand that these costs are part of ensuring the success of your project.

Ninth, don't accept the building until it works properly. What does this mean? It means you should insist on independent test and balance reports for the HVAC. Done by an independent certified test and balance engineer, this written report is essentially an audit report of the subcontractor's mechanical work. Insist, in your contract with the building, on a stable performance test period. Demand that the systems work appropriately for a test period, perhaps three or four months. To ensure problems are corrected, stipulate that there will be a retainage on the total contract — money is the only thing that talks in construction. Demand that you have complete systems documentation — manuals, shop drawings, operating instructions, and the like. Too often these disappear, cleaned up with the construction debris.

And tenth, the same as the first piece of advice — hire a preservation consultant and let him or her fight your battles for you. But, like every other consultant, be prepared to pay them. You want to avoid the cost? Who on your staff has the time, and expertise, to spend two or three hours a week bird-dogging these issues and problems? If you can't come up with a good answer, then hire a preservationist and count on him or her to represent your interests.

SUPPLIERS AND OTHER USEFUL INFORMATION

The suppliers listed here are not specifically recommended or endorsed by Chicora Foundation, Inc. nor is this list represented as being inclusive (for most categories there are dozens of additional companies or suppliers). We do, however, have reason to believe that the suppliers listed are reliable, carry appropriate materials, and have been responsive to our needs in the past.

Acetate Film Storage

Image Permanence Institute, PO Box 9887, Rochester, NY 14623, 716/475-5199

Air Monitoring

K&M Environmental Air Sampling Systems, 2421 Bowland Parkway, Unit 102, Virginia Beach, VA 23454, 800/808-2234 (minimum detectable conc.: NO_x 60 ppb, SO_2 13 ppb, O_3 6 ppb)

Barriers

Masterpack, 50 W 57th Street, 9th Floor, New York, NY 10019, 800/922-5522

Dehumidifiers, Add-ons for HVAC systems

Decton, Inc., PO Box 2076, South Burlington, VT 05407, 802/862-8343

Heat Pipe Technology, Inc., PO Box 999, Alachua, FL 32615, 800/393-3464

Air Technology Systems, Inc., 1572 Tilco Drive, Fredrick, MD 21701, 301/620-2033 (desiccant)

Kathabar, Inc., PO Box 791, New Brunswick, NJ 08903, 908/356-6000 (desiccant)

Munters Cargocaire, 79 Monroe St., Amesbury, MA 508/388-0600 (desiccant)

Dehumidifiers, portable industrial

Ebac Systems, Inc., 106 John Jefferson Road, Suite 102, Williamsburg, VA 23185, 800/433-9011

Desiccant, buffered

Art-Sorb, Chris Schnee, Fuji Silvsia Chemical, Bank of America Financial Center, 121 SW Morrison St, Suite 865, Portland, OR 97204, 800/795-9742

Fans

W.W. Grainger with branch stores nationwide. Look in your phone book under Grainger. National toll-free number is 800/323-0620

Filtration, gaseous pollutant

Purafil, PO Box 1188, Norcross, GA 30091, 800/222-6367

Filtration, particulate add-ons and filters

3M Filters, 800/388-3458

Farr Company, PO Box 92187, Los Angeles, CA 90009, 800/333-7320

Schuller Filtration Division, PO Box 5108, Denver, CO 80217, 800/654-3103

Permatron Corp., 11400 Melrose St., Franklin Park, IL 60131, 800/882-8012

Cameron-Yakima, Inc., PO Box 1554, Yakima, WA 98907, 509/452-6605

American Air Filter Products, PO Box 35690, Louisville, KY 40232

Filtration, portable particulate

Research Products Corp., Madison, WI 53701, 608-257-8801

Euroclean, 907 W Irving Park Road, Itasca, IL 60143, 800/323-3553

Humidification

DriSteem Humidifier Company, 14949 Technology Drive, Eden Prairie, MN 55344, 800/369-1478

Humidity cards

Light Impressions, PO Box 940, Rochester, NY 14603, 800/828-6216

University Products, Inc. PO Box 101, Holyoke, MA 01041, 800/628-1912

Hygrometers, digital

Inexpensive, but accurate

Baxter Healthcare Corp., Scientific Products Division, 1430 Waukegan Road, McGraw Park, IL 60085, 312/689-8410

Light Impressions, PO Box 940, Rochester, NY 14603, 800/828-6216

University Products, Inc. PO Box 101, Holyoke, MA 01041, 800/628-1912

Your local Radio Shack has several varieties

More expensive, for calibration

Vaisala, Inc., 2 Tower Office Park, Woburn, MA 01801, 617/933-4500

Hygrothermographs (recording hygrometers)

OMEGA Engineering, Inc., PO Box 4047, Stamford, CT 06907, 800/622-2378

Isoperms

Sebera, Donald K., Isoperms: An Environmental Management Tool, available from The Commission on Preservation and Access, 1400 16th Street, NW, Suite 740, Washington, D.C. 20036, 202/939-3400

Paint, low VOC

Pace Chem Industries, Inc., 779 S. LaGrange Ave., Newbury Park, CA 91320, 805/499-2911

AFM Enterprises, Inc., 1140 Stacy Ct., Riverside, CA 92507, 714/781-6860

Pollutant testing

Mr. Christopher Muller, Purafil, PO Box 1188, Norcross, GA 30091, 800/222-6367

Preservation Index

Reilly, James M., Douglas W. Nishumura, and Edward Zinn, New Tools for Preservation: Assessing Long-Term Environmental Effects on Library and Archives Collections, available from The Commission on Preservation and Access, 1400 16th Street, NW, Suite 740, Washington, D.C. 20036, 202/939-3400

Scavengers

Pacific Silvercloth, Mr. Gary Greene, Wamsutta Industrial Products, Springs Industries, PO Drawer 10232, Rock Hill, SC 29731, 803/324-6630

Conservation Resources, 8000-H Forbes Place, Springfield, VA 22151, 800/634-6932

University Products, Inc. PO Box 101, Holyoke, MA 01041, 800/628-1912

Vacuums, HEPA

Lab Safety Supply, Inc., PO Box 1368, Janesville, WO 53547, 800/356-0783

Vapor Barriers

Sto-Cote Products, Inc., PO Drawer 310, Richmond, IL 60071, 800/435-2621.

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1983 *Office Work Can Be Dangerous to Your Health*. Pantheon Books, New York.

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